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CONTROL SYSTEM

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Fig. 1.

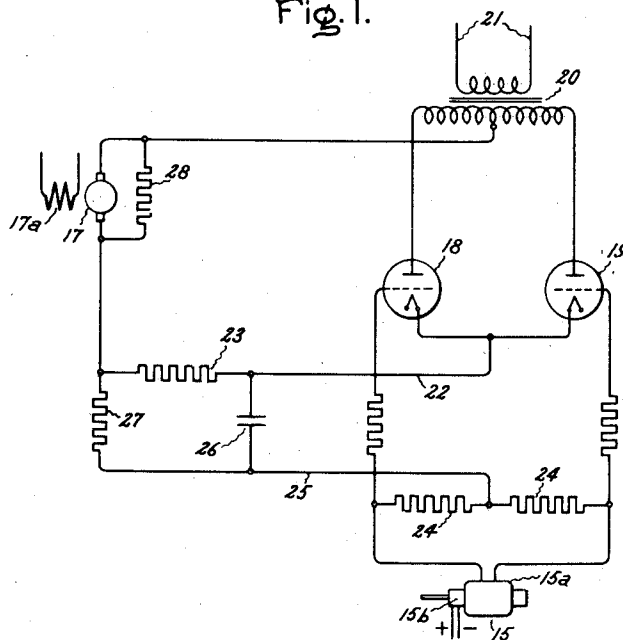
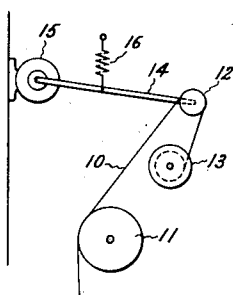


Fig. 2.



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UNITED STATES PATENT OFFICE

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CONTROL SYSTEM

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3 Claims. (Cl. 242-45)

This invention relates to control systems, more particularly to systems for controlling apparatus for reeling a length of material and the like, and it has for an object the provision of a simple, reliable, and improved system of this character.

The invention has application to wire drawing machines in which the drawn wire is wound upon a reel as it is unwound from the last capstan of the machine. In the reeling of fine copper wire such as #42 which has a diameter of .0025 inch, it is important to maintain the tension in the wire between the last capstan and the reel substantially constant. Tension control is also important for the winding of all sizes of wire, particularly in cases in which the wire is to be annealed. Heretofore, controls have been devised for the purpose of maintaining the tension substantially constant. The controls used heretofore have left something to be desired in that they were subject to hunting action which often resulted in breakage and large spoilage losses. Accordingly, a further object of the invention is the provision of a reeling control system in which means are provided for minimizing hunting action of the control.

In one form of the invention, the reel upon which the length of material is being wound is driven by means of an electric motor which is connected in the output circuit of suitable electric valve apparatus. The electric valve apparatus is provided with a control grid to which a control voltage is applied for controlling the current supplied to the reel motor. Means responsive to variations in the tension of the material are provided for supplying a control voltage to the grid of the valve apparatus to control the output current so as to counteract and reduce the variations in tension, and an electrical energy storage device is connected to the output circuit and to the grid circuit for supplying an opposing voltage to the grid so as to eliminate hunting action.

For a better and more complete understanding of the invention, reference should now be had to the following specification and to the accompanying drawing in which Fig. 1 is a simple, diagrammatical representation of an embodiment of the invention, and Fig. 2 is a diagrammatical illustration of parts of a wire drawing machine illustrating one application of the invention.

Referring now to the drawing, a length of fine wire 10 is being unwound from a capstan 11, passed upwardly over a pulley 12 and downwardly to the take-up reel 13. The pulley 12 is mounted on an arm 14 which is clamped to the

rotor member of a rotary induction device 15 which functions as an induction voltage regulator. This device is mounted in a suitable location on the wire drawing machine. As thus constructed the pulley 12 is arranged in a loop of the wire and tends to rotate in a clockwise direction by the tension of the wire constituting the loop. A spring 16 urges the arm 14 in a counterclockwise direction against the tension in the loop.

The reel 13 is driven by a suitable electric motor 17 which is supplied from suitable electric valve apparatus illustrated as a pair of thyratrons 18 and 19 which are connected for full wave rectification. Motor 17 is provided with a field winding 17a which is connected to a suitable source of excitation. The anodes of the thyratrons are connected to opposite terminals of the secondary winding of a supply transformer 20, the primary winding of which is connected to a source of alternating current supply which is represented by the conductor 21.

The reel motor 17 is connected in the output circuit of the electric valve apparatus. This circuit is traced from the terminals of the secondary winding of transformer 20 to the anodes of the thyratrons, thence to the cathodes, conductor 22, resistor 23, armature of reel motor 17 to the midtap of the secondary winding of the supply transformer.

The induction voltage regulating device 15 comprises a stator member 15a and a rotor member 15b, each carrying a winding (not shown). These windings are inductively related. One of the windings, e. g. the rotor winding, is connected to a single phase alternating voltage source which preferably is the same source as the source 21, and thus the rotor winding is a primary winding. The stator winding which is the secondary winding is connected across a resistance potentiometer 24, the opposite terminals of which are connected to the grids of the electric valves 18 and 19 as shown. A connection 25 is provided between the midpoint of potentiometer 24 and biasing resistor 23 by means of which a suitable negative bias is applied to the grids.

In order to minimize hunting action of the apparatus, a suitable electrical energy storage device illustrated as a condenser 26 is connected from the output or cathode-anode circuit of the electric valve apparatus to the grid circuit so as to apply to the grid circuit a voltage which is opposite in polarity to the voltage which the induction regulator 15 supplies to the grids during the positive half-cycle of anode voltage. In

other words, the voltage applied by the induction voltage regulating device to each grid is positive during the half-cycle that the anode voltage of the corresponding anode is positive, and the voltage applied by the condenser 26 is negative.

It will be noted that the upper terminal of the condenser 26 is connected to the right-hand or positive terminal of the bias resistor and that the lower terminal of the condenser is connected through a resistor 27 to the left-hand or negative terminal of the bias resistor. Thus, when current is flowing in the output circuit of the electric valve apparatus, the condenser is charged by the voltage across the bias resistor. The resistor 27 has a very substantial ohmic resistance and it governs the rate of charge of the condenser. Hence it is referred to as the condenser charging resistor. A suitable dynamic braking resistor 28 is connected across the armature of the reel motor.

With the foregoing understanding of the elements and their organization in the complete system, the operation of the system itself will readily be understood from the following description.

For each position of the arm 14, with the arm stationary, the electric valve apparatus supplies a corresponding current to the reel motor. Assuming the system to be in operation with wire passing from the last capstan 11 of the drawing machine and about the pulley 12 to the take-up reel, the arm will occupy a position such that the current supplied to the reel motor will cause the motor to run at a speed such that the tension in the loop will balance the pull of the spring 16. Under these conditions, the voltage drop across resistor 23 will be approximately equal to the positive voltage supplied by the induction voltage regulating device to the grids of the electric valve apparatus.

If, at any time during the reeling operation, the tension of the wire should decrease below the predetermined value, which the system is designed to hold, the arm 14 will move upwardly in a counterclockwise direction. This rotates the rotor of the induction voltage regulator in a direction to increase the current supplied to the reel motor. As a result the speed of the motor increases and begins to counteract the decrease in tension.

As the motor current increases, the voltage drop across the bias resistor 23 also increases and this causes the charge on the condenser 26 to increase. However, on account of the substantial ohmic resistance of the condenser charging resistor, the charge on the condenser does not increase rapidly. Consequently, the opposing voltage or negative voltage applied by the condenser to the grid circuit is delayed, and as a result the initial increase in current supplied to the motor takes place at a very high rate. As the condenser charges and the voltage across the condenser becomes equal to the voltage drop across the bias resistor, the negative opposing voltage supplied to the grid circuit becomes substantially equal to the positive voltage supplied from the induction regulator and as a result the current supplied to the reel motor begins to decrease. This occurs before the arm 14 can start downwardly in response to the increase in tension. Thus, the control anticipates the return of the tension to normal value and reduces the current before the correct value of tension is restored.

If the tension should increase above the de-

sired predetermined value, the operation will be similar but the reverse of that described.

From the foregoing it will be noted that if the position of the arm 14 is changing, the positive voltage applied to the grid circuit is affected almost instantaneously, whereas the negative voltage is not instantly affected on account of the time required for the condenser to charge or discharge through the high resistance 27.

The result of this is to provide an effective anti-hunting circuit since the change in current in the reel motor circuit is very rapid and is determined to a considerable extent by the rate at which the length of the loop of wire is changing.

Although in accordance with the provisions of the patent statutes, this invention is described as embodied in concrete form and the principle thereof is described together with the best mode in which it is now contemplated applying that principle, it will be understood that the elements and connections shown are illustrative and that the invention is not limited thereto, since alterations and modifications will readily suggest themselves to persons skilled in the art without departing from the true spirit of the invention or from the scope of the annexed claims.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. A control system for apparatus for reeling a length of material comprising an electric valve provided with anode, cathode and control grid, driving means for the reel comprising an electric motor connected in the anode-cathode circuit of said valve, means connected to the cathode grid circuit of said valve and responsive to a variation in the tension of said material for supplying a control voltage to said grid to vary the current supplied to said motor to counteract said variation in tension, and means for preventing hunting comprising an electrical energy storage device having connections to said cathode-anode circuit to have energy stored therein in response to the current of said anode-cathode circuit and connected in said cathode grid circuit so that the algebraic sum of said control voltage and the voltage of said energy storage device is applied to said grid.

2. A control system for apparatus for reeling a length of material comprising an electric valve having an anode, cathode and control grid, an electric motor for driving the reel connected in the anode-cathode circuit of said valve, means responsive to variation in the tension of said material from a predetermined value for supplying a variable control voltage to said grid to control the current supplied to said motor to counteract said tension variation, said means comprising a pulley movably mounted in a loop of the material, and means for preventing hunting comprising a capacitor having connections to said anode-cathode circuit to be charged by the current thereof and connected in said cathode grid circuit to oppose said control voltage so that a change in said control voltage initially produces a relatively large change in said motor current and said change in said motor current is subsequently reduced as the charge on said condenser changes in response to the changing motor current.

3. A control system for apparatus for reeling a length of material comprising an electric valve provided with an anode, cathode and control grid, means for driving the reel comprising an electric motor connected in the anode-cathode circuit of said valve, a grid biasing resistor con-

nected in said cathode-anode circuit, means responsive to variations in the tension of the material for supplying a control voltage to said grid comprising a pulley movably mounted in a loop of the material and an induction voltage regulator actuated thereby, and means for minimizing hunting comprising a circuit in parallel with

5 said bias resistor including a capacitor and a series connected resistor for controlling the rate of charge of said capacitor and a connection from said capacitor to said grid so that the algebraic sum of said control voltage and the voltage of said capacitor is applied to said grid.

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